Create CLP-5130-1N Log Periodic Antenna: measurements report

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ABSTRACT

This technical report shows the results of the measurements performed on the antenna CLP-5130-1N from Creative. The test campaign was executed by the High Technology and Homologation Center (CATECHOM) at the University of Alcalá, Spain (http://www3.uah.es/catechom/). This analysis covers the following antenna parameters: standing wave ratio (SWR), radiation pattern and gain. The results are compared to the specifications provided by the manufacturer.

Keywords: SWR, gain, LPDA, antenna

1. INTRODUCTION

The CLP-5130 antenna is a high gain and broad band antenna widely used in the International Network of Solar Radio Spectrometers or e-Callisto (http://e-callisto.org/). It is a log-periodic dipole antenna (LPDA) manufactured by Creative Design Corporation [1]. The model used hereby is the CLP-5130-1N. The main parameters of the antenna are shown in table 1.

Table 1: CLP-5130-1N specifications from Creative

Parameter	Value
Frequency	50-1300 MHz
Forward gain	10-12 dBi
VSWR	Less than 2.0:1
Impedance	50 Ω

It is composed of 21 elements and it weights around 5 kg. It can be mounted both in horizonal or vertical position. It is also usual to find CLP-5130 antenna mounted on a rotor for automatic sun tracking (Figure 1). Its directivity, gain and low cost (around 500 euros) makes this antenna very attractive in the e-Callisto frame of solar radiospectrometers. Professional LPDA antennas may cost between 3000 to 5000 euros (Schwarzbeck antennas for instance). The main goal of this analysis is to verify the parameters provided by the manufacturer.

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Figure 1: CLP-5130-1N Log periodic antenna

2. VOLTAGE STANDING WAVE RATIO

This section describes the measurements of the voltage standing wave ratio or VSWR. The manufacturer states that the CLP-5130-1N antenna has a VSWR of less than 2.0:1 (see Figure 2).

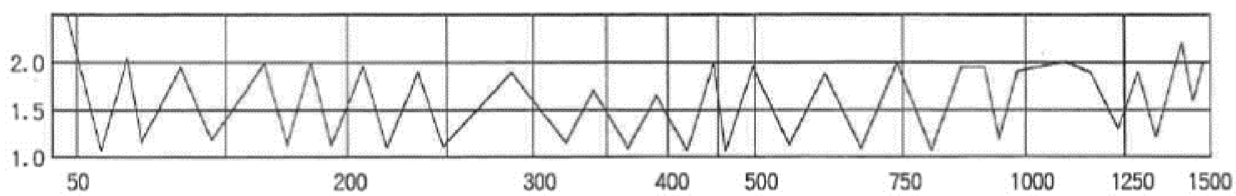

Figure 2: CLP-5130-1N VSWR. Manufacturer specification

Figure 3: CLP-5130-1N inside the chamber

The VSWR measurements were performed at the CATECHOM facilities inside a semi-anechoic chamber (Figure 3). The chamber was fully covered with ferrite tiles as electromagnetic absorbers. This feature made the chamber to become an anechoic chamber from 30 MHz to 1 GHz. Above 1 GHz, the chamber remained its semi-anechoic behaviour, since no absorbers were placed on the floor. The PNA 8363B vector network analyzer (VNA) from Agilent Technologies was used. The VNA was previously calibrated using the Ecal N4692A calibration kit from Agilent Technologies.

Obtained results are in line with the manufacturer specification (Figure 4). A frequency sweep was performed from 30 MHz to 1700 MHz. In general, the VSWR remains below 2. As shown in Figure 5, the first frequency at which the VSWR goes below 2 is around 50 MHz. This matches the low limit of the operating frequency stated by the manufacturer (see Table 1). Again, around 1300 MHz, the VSWR goes above 2, so we can suppose that this was the criterion used by the manufacturer to determine the upper frequency limit.

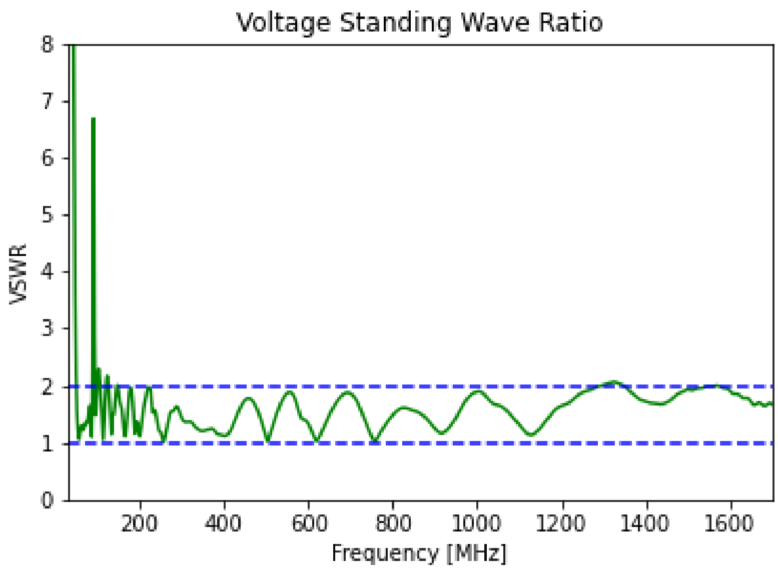

Figure 4: Measured VSWR

However, the results show that a non-expected increase of VSWR centered around 90 MHz.the results. In addition, the minimum values of VSWR do not coincide with those inferred looking at Figure 2 (see Table 2). For example, Figure 2 shows a maximum around 500 MHz, which is the opposite to the results obtained at the laboratory.

Table 2: Minimum VSWR values

Frequency (MHz)	VSWR
256.493	1.02:1
502.818	1.03:1
620.762	1.03:1
757.493	1.03:1

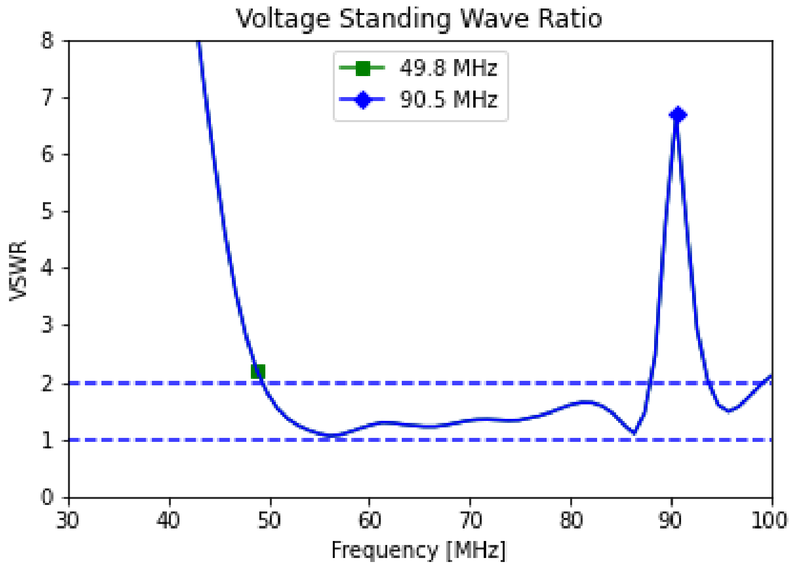

Figure 5: VSWR. Main findings

3. RADIATION PATTERN

Due to the physical dimensions of the antenna, it was not possible to determine the radiation pattern inside the semi-anechoic chamber. It was necessary to do an open field measurement or OTAS (Open Area Test Site) [2]. The method used was the SAM standard antenna method or reference antenna method, in which a known and well characterized antenna is used. The minimum distance between antennas is given by equation 1, where L is the length of the longest element of the CLP5130 antenna (1.3 meters) and λ is the wave length.

$$R = \frac{2L^2}{\lambda} \ , \qquad (1)$$


Figure 6: EMCO 3142 transmitting antenna

In this test, the CLP-5130-1N antenna is working as a receiving antenna mounted on a non-conductive vertical mast. The radiation pattern is obtained by using a known transmitting antenna located at 10 meters from the receiving antenna. Both antennas are aligned and located 2 meters above the ground. The PNA 8363B vector network analyzer (VNA) from Agilent Technologies is used for transmission, reception and analysis. The transmitting antenna is the Biconilog EMCO 3142 from ETS Lindgren (Figure 6).

Figure 7 shows an example of the test setup. The CLP-5130-1N antenna is then turned at intervals of 15 degrees to cover the 360 degrees, following marks previously drawn on the ground. The measurements were done both for horizontal (Figure 7) and vertical polarization (Figure 8).

Figure 7: Radiation pattern. Test setup. Horizontal Polarized Mount (E-Plane)

Figure 8: Radiation pattern. Test setup. Vertical Polarized Mount (H-Plane)

The manufacturer provides the radiation pattern in the antenna datasheet [1] as shown in Figure 9. The measured pattern for 110 MHz is shown in Figure 10 in normalized values. Both patterns are very similar in shape and values.

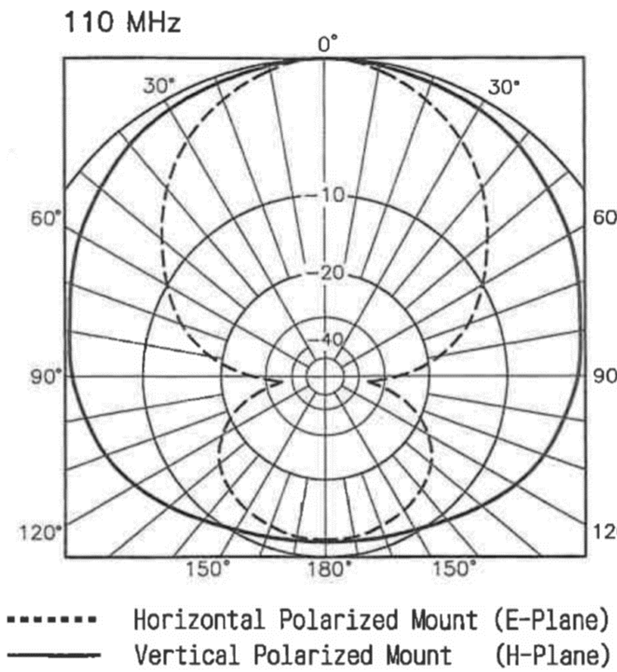

Figure 9: CLP-5130-1N. Radiation pattern (average) given by Creative at 110 MHz

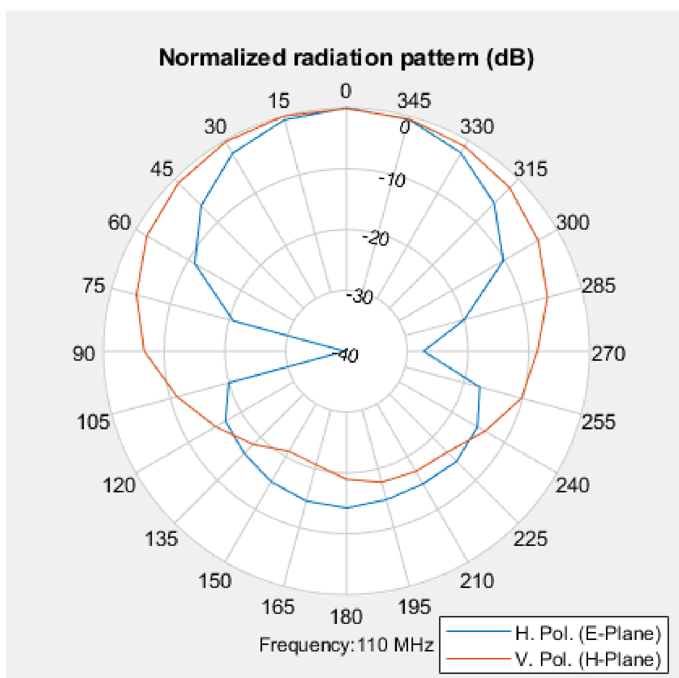

Figure 10: CLP-5130-1N. Radiation pattern measured at 110 MHz

Radiation patterns for all the frequency range were calculated. Figure 11 shows the radiation patterns for horizontal polarization while Figure 12 shows the radiation patterns for vertical polarization. In vertical polarization, the antenna directivity feature is notably affected. This is why, the manufacturer states that the antenna is designed for horizontal polarized base station, although vertical polarization is also possible.

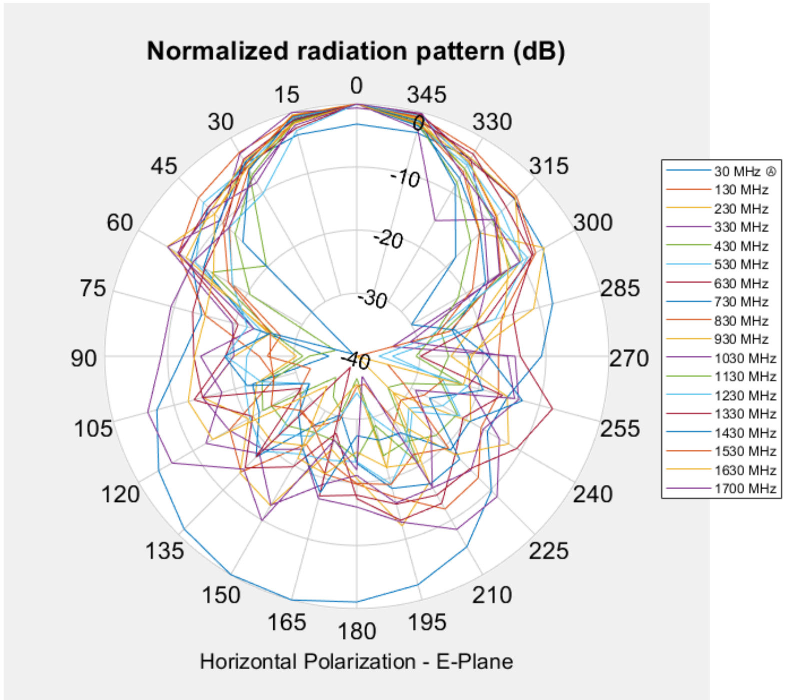

Figure 11: Normalized radiation patterns for different frequencies (horizontal polarization)

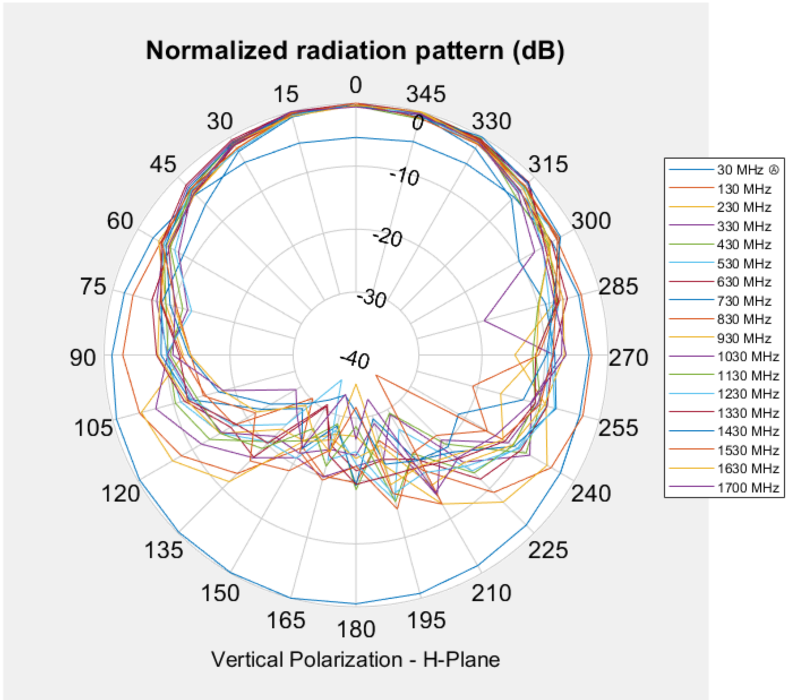

Figure 12: Normalized radiation patterns for different frequencies (vertical polarization)

4. GAIN

The manufacturer states the values shown in table 3 for gain. Gain was measured by using the biconilog receiver pattern antenna CBL6143A from Schaffner 13. Measured gains are shown in Figure 14 and Figure 15. The values obtained shows that the antenna starts working properly above 50 MHz. Gain is below 10 dB in most of the cases. Only for certain frequencies and for the horizontal polarization the 12 dB are reached. According to this results, it seems that the manufacturer is considering possible ground reflections that may increase the gain to 10 $\sim$ to 12 dBs when talking about "Average Ground". For e-Callisto application, the scenario would be more like "Free Space", since the antenna is usually located high above the ground and tracking the Sun most of the time. Results also shows a loss of the antenna efficiency around 90 MHz, in line with the VSWR value shown in Figure 5.

Table 3: Manufacturer gain specification

	Average Ground	Free Space
Forward gain	10 $\sim$ 12	6 $\sim$ 7

Figure 13: CBL6143A antenna (Schaffner) used for gain calibration

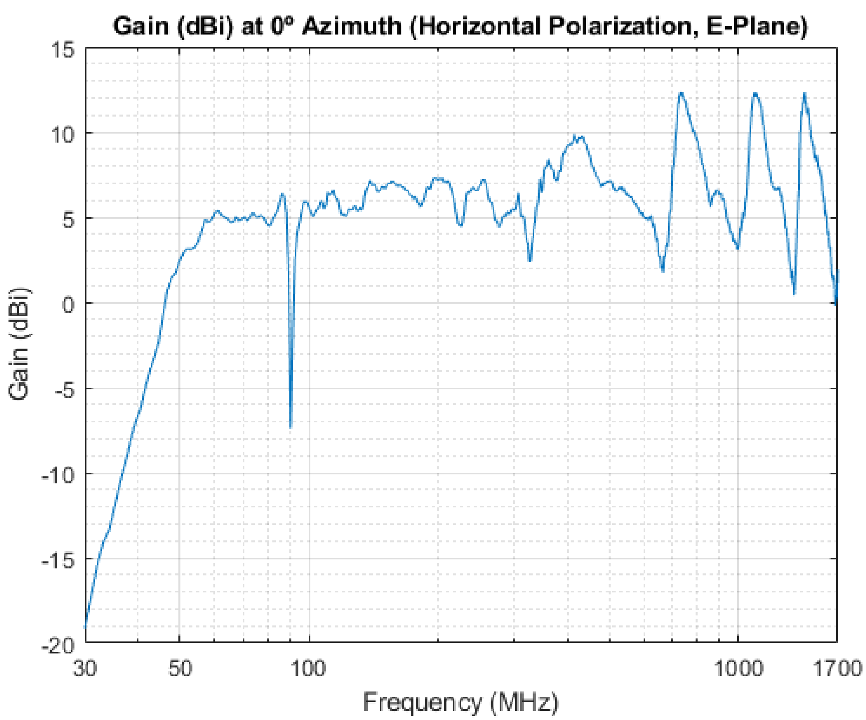

Figure 14: Measured gain for horizontal polarization

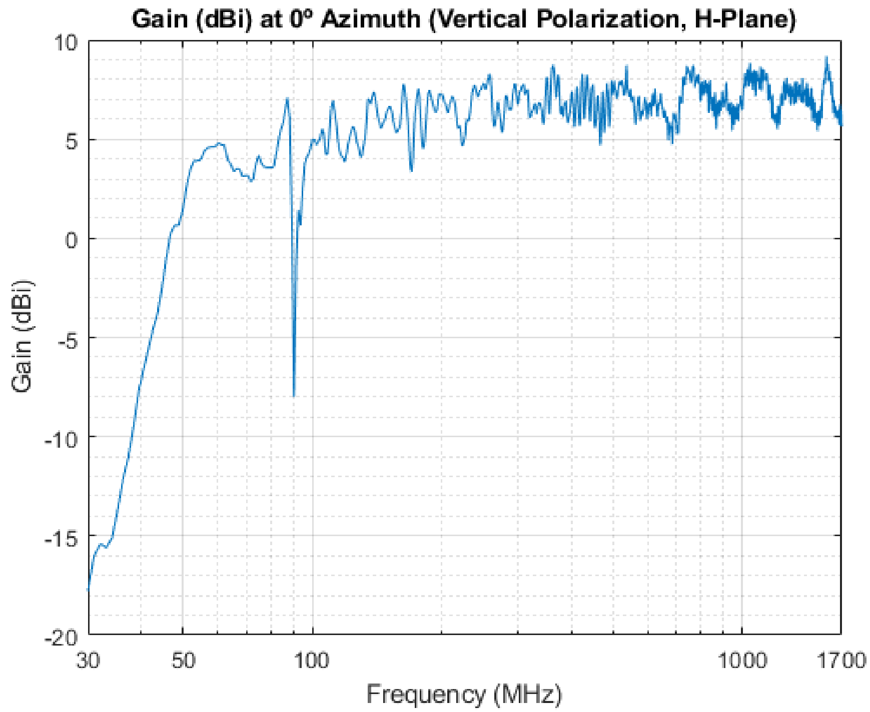

Figure 15: Measured gain for vertical polarization

DATA AVAILABILITY STATEMENT

Raw data and scripts are available at https://celestina.web.uah.es/ (see Resources).

ACKNOWLEDGMENTS

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REFERENCES

[1] Create, "CLP5130-1 Instruction Manual." Creative Design Corporation, 1994 http://www.cd-corp.com/english/index.html. (Accessed: September 2021).

[2] IEC, [*CISPR 16-1-6 Edition 1.0 2014-12. Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-6: Radio disturbance and immunity measuring apparatus - EMC antenna calibration*].